



Practitioner's Docket No.: 518833-0000255
Client Reference No.: VTX0053-US

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: CHRIS J. GOODINGS Confirmation No: 3971
Application No.: 10/035,073 Group No.: 2667
Filed: December 28, 2001 Examiner: Dyke, Kerri M.
For: FRAME STRUCTURE WITH DIVERSITY

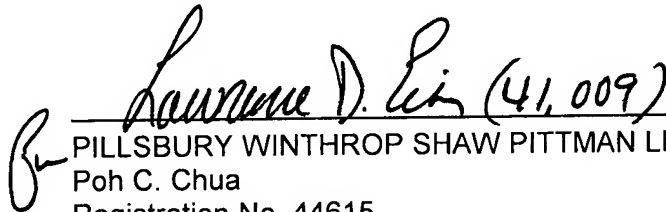
**Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450**

SUBMISSION OF PRIORITY DOCUMENT

Attached please find the certified copy of the foreign application from which priority is claimed for this case:

<u>Country</u>	<u>Application Number</u>	<u>Filing Date</u>
United Kingdom	0031812.1	12/29/2000
United Kingdom	0031817.0	12/29/2000

Date: 5/23/2006
P.O. Box 10500
McLean, VA 22102
Telephone: (703) 770-7900
Facsimile: (703) 770-7901
Customer Number: 00909


PILLSBURY WINTHROP SHAW PITTMAN LLP
Poh C. Chua
Registration No. 44615

THIS PAGE BLANK (USPTO)

BEST AVAILABLE COPY



For Innovation

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

The undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

I do certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an endorsement, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1985 with the same name as that with which it was registered immediately before re-registration or the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

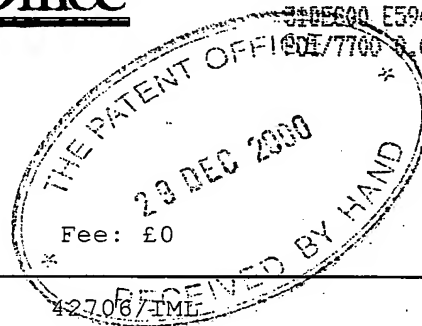
Signed

Dated 17 May 2006

THIS PAGE BLANK (USPTO)

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form.)



The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference

2. Patent application number
(The Patent Office will fill in this part)**0031812.1****29 DEC 2000**3. Full name, address and postcode of the or of each applicant (underline all surnames)VTECH COMMUNICATIONS, LTD.
23/F., Tai Ping Industrial Centre
Block 1, 57 Ting Kok Road
Tai Po, N.T., Honk Kong

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of incorporation

Hong Kong

1435001001

4. Title of the invention

Frame Structure With Diversity

5. Full name, address and postcode in the United Kingdom to which all correspondence relating to this form and translation should be sent

Reddie & Grose
16 Theobalds Road
LONDON
WC1X 8PL
91001HASLTINE LAKE
120 REDCLIFF STREET
BRISTOL
BS1 6HU
SUE SUTHERLAND

Patents ADP number (if you know it)

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application
(If you know it)Date of filing
(day/month/year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
(day/month/year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

- a) any applicant named in part 3 is not an inventor, or
 - b) there is an inventor who is not named as an applicant, or
 - c) any named applicant is a corporate body.
- See note (d))

YES

THIS PAGE BLANK (USPTO)

Enter the number of sheets for any of the following items you are filing with this form.
Do not count copies of the same document.

Continuation sheets of this form

Description	7
Claim(s)	SPR
Abstract	
Drawing(s)	3 + 3

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature

Date
28 December 2000

12. Name and daytime telephone number of person to contact in the United Kingdom

I M LOVELESS
020-7242 0901

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or such direction has been revoked.

Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.

THIS PAGE BLANK (USPTO)

TITLE OF THE INVENTION

Frame Structure with Diversity

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to wireless digital communications. In particular, the invention relates to a data frame structure for use in a wireless communications system which provides improved communications performance under interference conditions.

2. Background Art

The issue is involved with single or multiple handset, frequency hopping radio systems. For simplicity, the discussion in this proposal will be based on a single handset system, but the concepts described will equally apply to a multiple handset system. The discussion is also based on the use of the proposal in a cordless telephone system, but again the application of the proposal is not limited to such a system.

A frequency hopping radio system is one which transmits data (which in the context of cordless phones includes voice traffic) on a series of frequencies. At any one time, only one frequency is used but this frequency changes (hops) in the time domain. The sequence of frequencies used is known as the hop pattern.

Figure 1 illustrates a typical Time Division Duplex (TDD) frequency hopping system by showing the frequency in use as a function of time. The illustration is for a single-handset cordless phone system in which the basestation (BS) transmits to the handset first followed by the handset (HS) reply. The RSSI period at the end of

the frame is used to measure the level of interference on any particular frequency for interference mitigation and is optional. The shaded areas indicate guard bands to allow for frequency and switching settling during which no data transmission can occur.

A significant issue with this type of system is that of interference. This may be on a single (constant) frequency such as would be produced by a non-hopping radio transmitter or it could be generated by a similar hopping system. This situation is illustrated in Figure 2 which shows a time versus frequency plot for two hopping systems and a fixed-frequency system. The system being considered is shown in grey with the interferers shown hatched. Each time the frequency of the system clashes with an interferer, data may be lost with a resultant degradation of voice or data quality. These cases are ringed in the figure.

An important point with this figure is that the effects of fixed-frequency (or slowly time varying) interference can be mitigated against by frequency adaption. In other words, the blocked frequencies would be detected and avoided. However, interference from systems with a hop speed similar or faster than the link in question cannot be avoided by frequency adaption.

DETAILED DESCRIPTION OF THE INVENTION

1. Proposed Frame Structure With Diversity

The proposal which is the subject of this application is to transmit each packet of data twice in successive hops. Thus in each hop there are two transmit slots and two receive slots. This is illustrated in Figure 3. Each frame consists of the following:

- A guard band for PLL settling (shown in grey)
- A transmit preamble
- Transmit data for the current frame
- Re-transmitted data from the previous frame
- A guard band for T/R switch settling (shown in grey)
- A receive preamble
- Receive data for the current frame
- Re-received data from the previous frame
- A guard band for PLL settling (shown in grey)
- Time for RSSI measurement

The key to this proposal is that data is now transmitted twice on successive hops so that there is both frequency and time diversity in the data transmission. The data protocol must contain error detection so that data received correctly can be used in preference to data received in error. This type of scheme can successfully mitigate against fast hopping interference.

In the case of two identical hopping systems with different hop patterns of length n , the probability of the hop frequencies clashing and hence interference occurring is of order $1/n$. With frequency diversity in place, the probability of two successive hop frequencies clashing and hence interference occurring is of order $1/n^2$.

The time diversity in the proposed system has the additional advantage that a degree of mitigation will also occur against short-lived wide-band interference.

2. Data Handling in the Proposed System

In the proposed system, identical voice data is transmitted twice in successive frames along with CRC error detection. On receipt of this data, the receiver must make the decision as to which data should be used. An example flow diagram for

this decision process is shown in Figure 4. In this diagram, data being received for the first time is termed D_1 while data being received for the second time is termed D_2 .

Initially, the first data transmission is received and its CRC is calculated to see whether the data is correct. If the data has been received correctly on the first occasion, the second data transmission is not required and so any data received during this second period can be ignored. The good data is placed into a buffer (or memory) for later use. However, if the data received in the first slot is incorrect, the second repeat will be required. This is again checked for errors using the CRC encoding. If this is shown to be good it can be placed into the buffer for future use. However, if the second version of the data is also shown to be in error then null data should be placed into the buffer.

Once this process is complete, the data residing in the buffer can be used for further processing and final output. This data will either be the correct data from one or other of the transmissions or it will be null data in the event that both transmissions were corrupted.

3. Power Saving in Frequency Diverse Mode

A key consideration in handheld radio systems is the power consumption since this reflects directly onto the battery lifetime. Clearly, the use of a diverse system such as is proposed will impact the power consumption since data is being sent twice. To put this another way, if the data was only sent once then the radio transmitter and receiver would only be required to be switched on for about 60% of the time (not half due to settle times and preambles).

BEST AVAILABLE COPY

The concept described above can be extended in order to minimise the impact of the diversity on the power consumption. This should be considered in two stages, the receive and the transmit processes.

With reference to Figure 4, clearly the receiver is aware if the first reception of the data packet is good. Under these circumstances, there is no need to receive the second copy of the data and so the receive path can be powered-down during the time the second copy is being sent. For this to be possible it is important that the second copy of the data from the previous frame is sent after the first copy of the data from the current frame (as shown in Figure 3). Typically this will save a significant amount of power since under normal conditions the data will be received correctly on the first occasion. Assuming that the RF device consumes the same power as the baseband device in the radio system, the battery lifetime could be extended by up to 15% using this technique, depending on the levels of interference present.

While the above-described embodiment in which the redundant transmission of the previous frame's data occurs after the transmission of the new data allows for power savings through strategic deactivation of the receiver, in other embodiments it may be desirable to reverse the order of data transmission. Specifically, buffer memory and computational requirements can be reduced by retransmitting the prior frame's data before transmitting new data. This allows the receiver to choose between the primary and redundant transmissions of any given data, and subsequently pass that data on for processing, before any subsequent new data is received and stored. Thus, by reversing the order of data transmission from that

BEST AVAILABLE COPY

shown in the drawings, the receiver need not handle multiple different subpackets of data simultaneously.

While reducing the operation time of the receiver can reduce the power consumption of the radio system, substantial reductions in power can also be obtained by reducing the operation time of the transmitter as well, inasmuch as transmitters typically consume greater amounts of power than receivers. Therefore, in some applications of the invention it may be desirable to condition diversity operation upon the satisfaction of an operating condition. For example, a cordless telephone may be designed such that it only transmits the diversity data from the previous frame when channel quality is poor, such as when the error rate exceeds a threshold level. Channel quality could be evaluated, and diversity transmission controlled, for all frequencies in the hop sequence, or for each hop frequency separately. In addition to evaluation of channel quality, the choice between diversity and non-diversity modes may depend upon power reserves available in a battery-operated transceiver unit. For example, as a mobile telephone handset's battery nears depletion, the telephone may switch to non-diversity transmission mode to conserve battery power, thus choosing a communications link with greater error rate over battery depletion and a lack of any communications at all.

Other applications of the invention may incorporate an asynchronous diversity feature, such that improved communications performance is achieved for only one direction of a bidirectional link. For example, in a mobile telephone system in which a fixed base station is capable of transmitting data with substantially greater power than a small, battery-powered mobile telephone handset, data sent with low power

from the handset to the base station may be corrupted by channel interference even while high-powered transmissions from the base to the handset are received adequately. Thus, it may be desirable to implement diversity transmission of data by the mobile handset, along with diversity reception by the corresponding base station, while maintaining the opposite communications link in non-diversity mode.

4. Conclusions

A frame structure has been described which provides both frequency and time diversity. This has the ability to mitigate against both slow and fast fading interference. The example application described is a cordless telephone although the concepts could be extended to other systems.

Methods for reducing the consequence that the diversity has on the power consumption of the system has also been described.

THIS PAGE BLANK (USPTO)

BEST AVAILABLE COPY

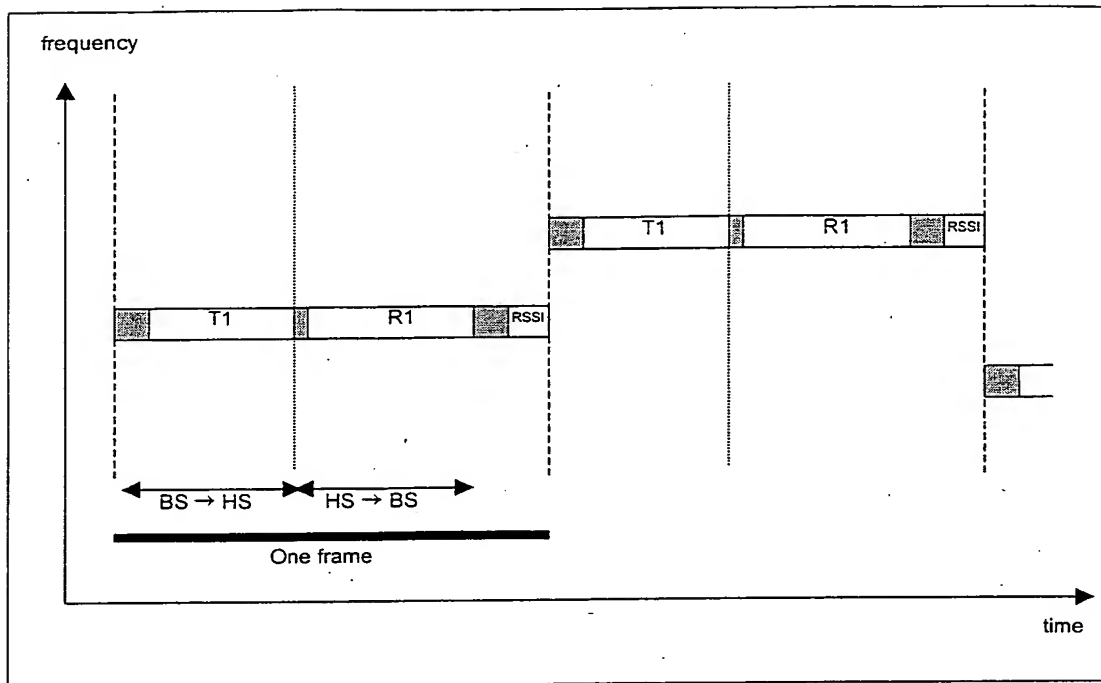


Figure 1 : Illustration of a Single-Handset TDD Hopping System

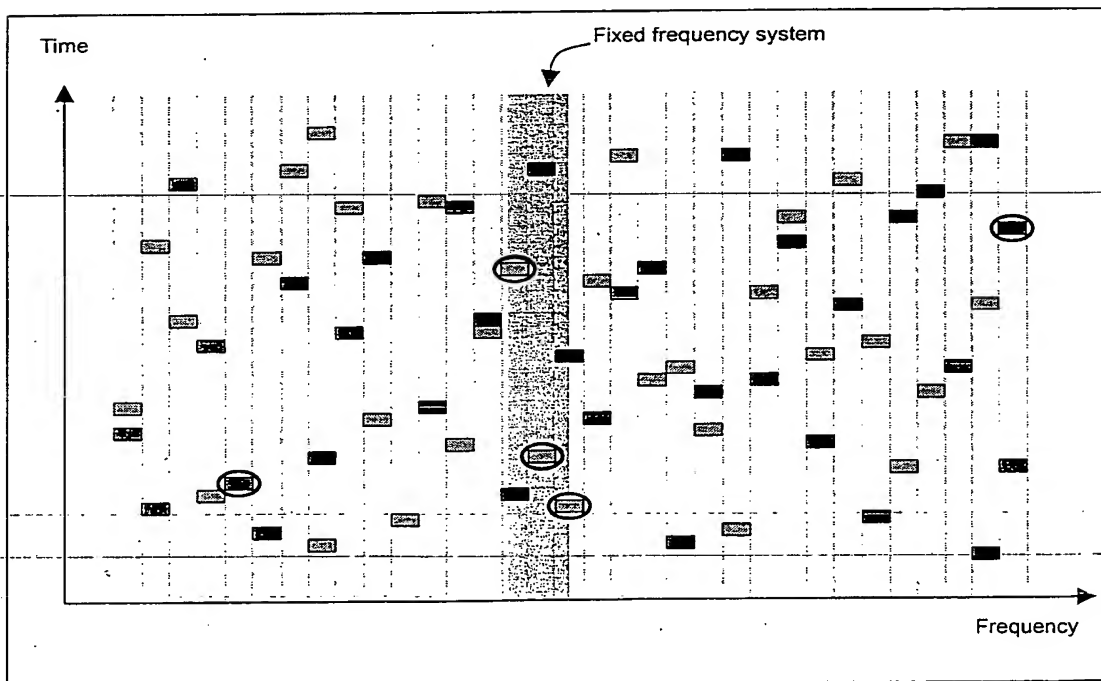


Figure 2 : Illustration of a Hopping System with Interference

THIS PAGE BLANK (USPTO)

BEST AVAILABLE COPY

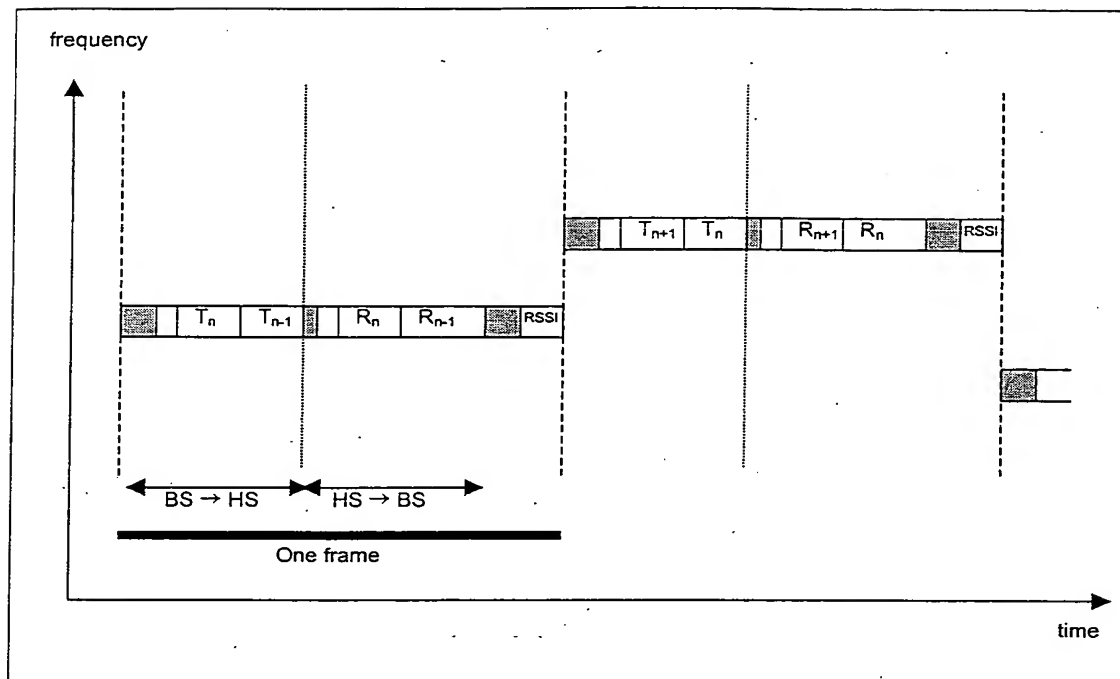


Figure 3 : Illustration of a Proposed Diverse Hopping System

THIS PAGE BLANK (USPTO)

BEST AVAILABLE COPY

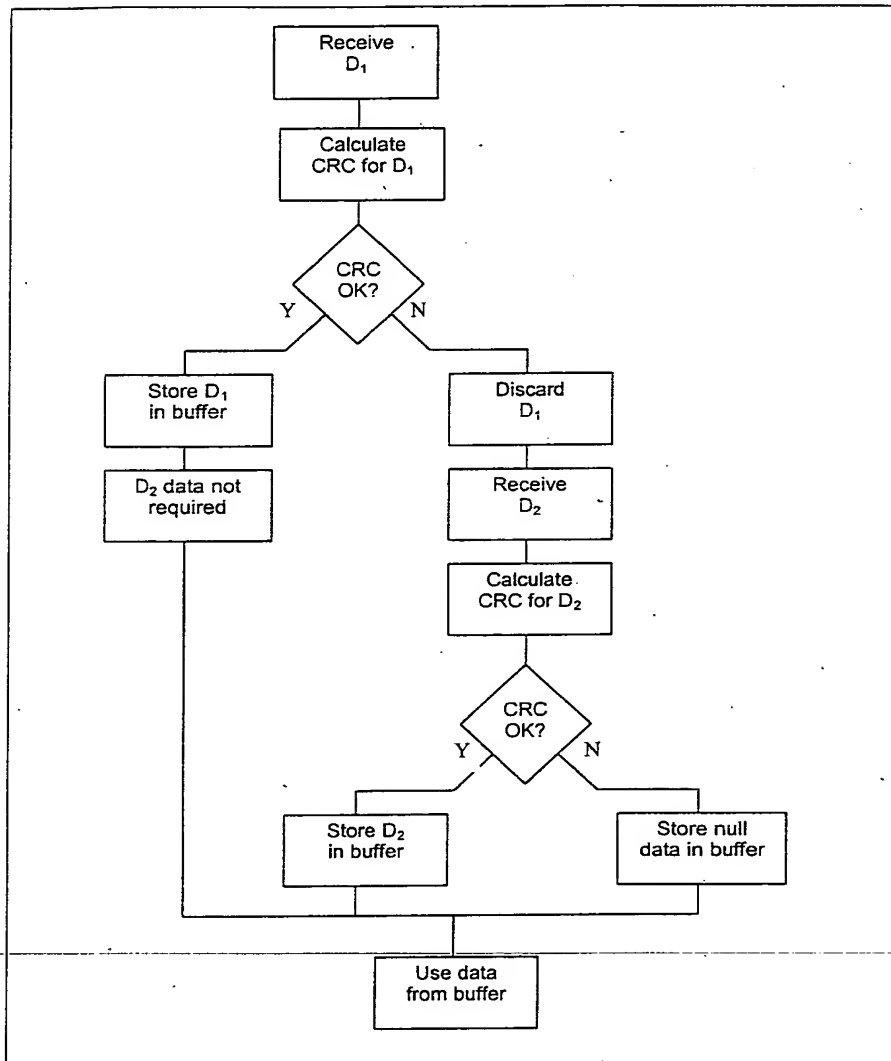


Figure 4 : Example Flow Chart for Data Handling

THIS PAGE BLANK (USPTO)